

# TCEQ Interoffice Memorandum

---

**To:** Ashley Wadick, Regional Director, R12  
Nicole Bealle, Special Assistant to the Regional Director, R12  
Daniel O'Brien, Special Assistant to the Regional Director, R12  
Kelly Keel Linden, Coastal & East Texas Area Director  
Tara Capobianco, Air Permits Division APWL Coordinator

**From:** Joseph T. Haney, Jr., M.S.  
Heather Reddick, M.P.H.  
Toxicology Division

**Date:** July 10, 2013

**Subject:** Health Effects Review of 2012 Ambient Air Network Monitoring Data in Region 12, Houston

---

## Key Points

- Notably, annual averages for all chemicals and metals were below their respective long-term air monitoring comparison values (AMCVs) for the third consecutive year in many years of sampling.
- The 2012 benzene concentration at the Marathon-sponsored site in Texas City is below TCEQ's long-term AMCV for the third consecutive year since monitoring began in 2005, and the annual benzene averages at other Texas City sites were also below the long-term AMCV.
- TCEQ has proposed removal of benzene from the Texas City Air Pollutant Watch List (Site# [APWL1202](#)) since data from recent years for the Marathon-sponsored site and other Texas City monitoring sites indicate sufficient achievements in reducing ambient air concentrations such that levels are no longer of concern for potential long-term, adverse health effects.
- Although benzene is currently on the Galena Park APWL (Site# [APWL1206](#)), data from 2008 to date continue to indicate sufficient achievements in reducing ambient air concentrations such that the reported levels are no longer of concern for potential long-term, adverse health effects. This determination should be considered in context with the [APWL protocol](#).
- Only approximately 0.0004% of measured hourly concentrations exceeded an odor-based AMCV. A few hourly levels of styrene, isoprene, and/or 1-butene monitored at two Region 12 sites could result in the perception of odors if people were exposed. Assuming exposure, the monitored concentrations would not be expected to cause direct, short-term adverse health effects (e.g., eye irritation), and the infrequency and low magnitude of the exceedances and other considerations (e.g., odor characteristics for isoprene and 1-butene) are not indicative of persistent, strong odors with the potential to cause odor-related health effects (e.g., nausea, headache).
- Lynchburg Ferry site data from recent years (2011-2012) demonstrate significant improvement in reducing exceedances of the styrene odor-based AMCV compared to historical data (2005-2010). The frequency, duration, and magnitude of these

concentrations have fallen sharply since 2005 such that for the last two years (2011-2012), they are within that routinely permitted for air permit applications. Thus, although styrene is currently listed on the APWL for this area (Site# [APWL1204](#)), 2011-2012 data indicate sufficient achievements in reducing ambient air concentrations such that the reported levels are no longer of concern for persistent, strong odors. This determination should be considered in context with the [APWL protocol](#).

## Background

The primary purpose of this memorandum is to convey the Toxicology Division's (TD) evaluation of ambient air toxics sampling conducted at monitoring sites in Region 12-Houston during 2012. The TD reviewed summary results for volatile organic compounds (VOCs) from 24-hour canister samples, 1-hour automated gas-chromatography (autoGC) VOC samples, 24- and 3-hour carbonyl samples, 24-hour polycyclic aromatic hydrocarbon (PAH)/semivolatile organic compound (SVOC) samples, and 24-hour metals samples from filters designed to collect particulate matter with an aerodynamic diameter of 2.5 microns or less (PM<sub>2.5</sub>) and from filters collecting particulate matter with an aerodynamic diameter of 10 microns or less (PM<sub>10</sub>). Except for lead, data for criteria pollutants (i.e., compounds having National Ambient Air Quality Standards (NAAQS)) were not evaluated for this memorandum. Appendix 1 contains a list of the target analytes evaluated for this review. Information regarding monitoring sites and target analyte data reviewed by the TD is presented in Table 1 and summarized below:

- 24-hour canister VOC sampling at 17 sites
- 24-hour carbonyl sampling at 2 sites
- 3-hour carbonyl sampling at 1 site
- 24-hour metals sampling at 5 sites
- 24-hour PAH/SVOC sampling at 1 site
- 1-hour autoGC VOC monitoring at:
  - 12 TCEQ and/or Enhanced Industry-Sponsored Monitoring (EISM) sites
  - 2 Attorney General-Temporary Injunction Monitoring sites (TIM)
  - 1 US Environmental Protection Agency (EPA)/DOJ-Industry Agreement Monitoring site (EPA/DOJAM)

**Table 1. Monitoring Sites Located in TCEQ Region 12**

County	EPA Site ID	Site Location	Network	Monitored Compounds
Brazoria	48-039-1003	<a href="#">Clute</a> <a href="#">426 Commerce St.</a>	TCEQ	VOC (24-hour canister)
Brazoria	48-039-0618	<a href="#">Danciger</a> <a href="#">Along US Hwy 1459 in Brazoria County</a>	EISM	VOC (autoGC)
Brazoria	48-039-1012	<a href="#">Freeport South Ave I</a> <a href="#">207 South Avenue I</a>	TCEQ	Metals (PM <sub>2.5</sub> )

County	EPA Site ID	Site Location	Network	Monitored Compounds
Brazoria	48-039-1016	<a href="#">Lake Jackson</a> <a href="#">109-B Brazoria Hwy 332-W</a>	EISM	VOC (autoGC)
Brazoria	48-039-0619	<a href="#">Mustang Bayou</a> <a href="#">FM 2917 @ County Road 169</a>	EISM	VOC (24-hour canister)
Galveston	48-167-0005	<a href="#">Texas City, Ball Park</a> <a href="#">2516 ½ Texas Ave.</a>	TCEQ	VOC (24-hour canister)
Galveston	48-167-0056	<a href="#">Texas City, 34<sup>th</sup> St.</a> <a href="#">2212 North 34th St.</a>	EISM	VOC (autoGC)
Galveston	48-167-1034	<a href="#">Galveston, 99<sup>th</sup> St.</a> <a href="#">9511 Avenue V ½</a>	TCEQ	VOC (24-hour canister)
Harris	48-201-0036	<a href="#">Jacinto Port</a> <a href="#">1st St. and Elsbeth St.</a>	TCEQ	VOC (24-hour canister)
Harris	48-201-1039	<a href="#">Deer Park</a> <a href="#">4514 ½ Durant St.</a>	TCEQ	VOC (autoGC, 24-hour canister), Carbonyls, Metals (PM <sub>2.5</sub> , PM <sub>10</sub> ), PAHs/SVOCs
Harris	48-201-0024	<a href="#">Houston, Aldine</a> <a href="#">4510 ½ Aldine Mail Rd.</a>	TCEQ	VOC (24-hour canister), Metals (PM <sub>2.5</sub> )
Harris	48-201-1035	<a href="#">Houston, Clinton</a> <a href="#">9525 ½ Clinton Dr.</a>	TCEQ	VOC (autoGC), Carbonyls, Metals (PM <sub>10</sub> )
Harris	48-201-1034	<a href="#">Houston, East</a> <a href="#">1262 1/2 Mae Drive</a>	TCEQ	Lead (TSP)
Harris	48-201-0057	<a href="#">Galena Park</a> <a href="#">304 Stewart St.</a>	TCEQ/Harris County	VOC (24-hour canister/Auto GC-Benzene)
Harris	48-201-0026	<a href="#">Houston, Channelview</a> <a href="#">1405 Sheldon Rd.</a>	TCEQ	VOC (autoGC)
Harris	48-201-0061	<a href="#">La Porte, Shoreacres</a> <a href="#">3903 ½ Old Hwy 146</a>	TCEQ	VOC (24-hour canister)
Harris	48-201-0069	<a href="#">Houston, Milby Park</a> <a href="#">2201-a Central St.</a>	TCEQ	VOC (autoGC)
Harris	48-201-6000	<a href="#">Houston, Cesar Chavez</a> <a href="#">4829A Galveston Rd.</a>	TCEQ	VOC (autoGC)
Harris	48-201-1015	<a href="#">Baytown, Lynchburg Ferry</a> <a href="#">1001 B Lynchburg Rd.</a>	TCEQ/EISM	VOC (autoGC, 24-hour canister)

County	EPA Site ID	Site Location	Network	Monitored Compounds
Harris	48-201-0617	<a href="#">Baytown, Wallisville Rd. 4727 Wallisville Rd.</a>	EISM	VOC (autoGC)
Harris	48-201-0307	<a href="#">Houston, Manchester/Central 9401 ½ Manchester Rd.</a>	TCEQ	VOC (24-hour canister)
Harris	48-201-0029	<a href="#">Tomball, NW Harris County 16822 Kitzman St.</a>	TCEQ	VOC (24-hour canister)
Harris	48-201-0055	<a href="#">Houston, Bayland Park 6400 Bissonnet St.</a>	TCEQ	VOC (24-hour canister)
Harris	48-201-0058	<a href="#">Baytown 7201 ½ Bayway Dr.</a>	TCEQ	VOC (24-hour canister)
Harris	48-201-0803	<a href="#">Haden Rd. (HRM-3) 1504 ½ Haden Dr.</a>	TCEQ/EISM	VOC (autoGC, 24-hour canister)
Harris	48-201-1049	<a href="#">Pasadena North <sup>1</sup> 702 Light Company Rd.</a>	TCEQ	VOC (24-hour canister)
Galveston	N/A	<a href="#">BP North America Products, Inc.-Texas City 31<sup>st</sup> St. (Between Texas Ave. and 5<sup>th</sup> Ave.)</a>	TIM	Benzene (autoGC)
Galveston	N/A	<a href="#">BP North America Products, Inc.-Texas City Logan St.</a>	TIM	Benzene (autoGC)
Galveston	N/A	<a href="#">Marathon Petroleum Company, LLC-Texas City 11<sup>st</sup> St. S. at 6<sup>th</sup> Ave. S.</a>	EPA/DOJAM	Benzene (autoGC)
Montgomery	48-339-0078	<a href="#">Conroe 9472A Hwy 1484</a>	TCEQ	VOC (24-hour canister)

<sup>1</sup> Last sample of 2012 was collected on July 14<sup>th</sup> due to an electrical issue.

All data collected at TCEQ monitors are analyzed by the TCEQ laboratory and should meet a 75% data completeness objective. At EISM monitors, data are collected by a third party contractor and should also meet a 75% data completeness objective. The data collected at the EPA/DOJAM and TIM monitors are analyzed by a third party contractor and should meet an 85% data completeness objective. One-hour autoGC VOC and 3-hour carbonyl data were evaluated for potential acute health (e.g., irritation), odor, and vegetation concerns, as were any 24-hour sample results (e.g., VOCs, carbonyls, metals) that exceeded short-term air monitoring comparison values (AMCVs). The annual averages from 1-hour autoGC and 24-hour samples (VOCs, carbonyls, and metals) were evaluated for potential chronic health and vegetation concerns. Measured chemical concentrations were compared to appropriate comparison values (e.g., National Ambient Air Quality Standards (NAAQS), TCEQ health-, odor-, and vegetation-based AMCVs). Information on AMCVs may be obtained via the internet

(<http://www.tceq.state.tx.us/implementation/tox/AirToxics.html>) or by contacting the TD (512-239-3900).

## Evaluation

### 1- and 3-Hour Concentrations

The vast majority of the 1-hour autoGC VOC and 3-hour carbonyl concentrations were below their respective TCEQ short-term, health-, odor-, and/or vegetation-based AMCVs. More specifically, about 99.9995% of the approximately 3,877,000 1-hour VOC measurements from TCEQ, EISM, and industry-sponsored autoGC monitors in Region 12 in 2012 were below their short-term AMCVs. Only four (approximately 0.0001%) hourly autoGC measurements collected in Region 12 in 2012 exceeded a TCEQ short-term, health-based AMCV (see discussion below). Approximately 0.0004% exceeded an odor-based AMCV, with no more than six exceedances for a chemical at any one site. Additionally, except for one very slight exceedance of the odor-based AMCV for acetaldehyde at Clinton Dr., all of the approximately 3,340 3-hour carbonyl concentrations measured in Region 12 in 2012 were below their respective AMCVs. That is, approximately 99.97% of the 3-hour carbonyl levels were below their respective short-term, health- and odor-based AMCVs. Therefore, we would not expect short-term, adverse health effects, vegetation effects, or odors to be associated with the vast majority of 1- and 3-hour measurements monitored in Region 12 in 2012.

Further evaluation was conducted for the monitored concentrations that exceeded their respective short-term, health- and/or odor-based AMCVs to determine the potential for adverse health effects or odors. Four concentrations of isoprene were the only instances in which any of the monitored 1-hour concentrations exceeded their respective short-term, health-based AMCVs in 2012. These exceedances occurred at the Lynchburg Ferry site monitor, where four hourly isoprene concentrations ranging from 25.1-155.4 ppb<sub>v</sub> were above the current interim short-term, health-based AMCV of 20 ppb<sub>v</sub>. However, this short-term AMCV was simply designed to help ensure that the long-term average at a site remains low (i.e., < 2 ppb<sub>v</sub>) as opposed to being a short-term concentration of actual potential health concern. The TCEQ is currently in the final stages of assessing the health hazards/risks of isoprene, including deriving a final health-protective, short-term AMCV more representative of the actual potential for short-term, adverse health effects. Using the latest scientific assessment methods, the final short-term, health-based AMCV will likely be at least an order of magnitude higher than the current interim value. In addition, these monitored hourly exceedances are significantly below isoprene levels attributable to short-term, adverse health effects. Therefore, exposure to these hourly concentrations would not be expected to cause short-term, adverse health effects.

The monitored 1-hour autoGC VOC concentrations that exceeded their respective odor-based comparison levels in 2012 are shown below in Table 2. The total number of odor-based AMCV autoGC exceedances in Region 12 in 2012 (14 exceedances) is 26% lower than that in 2011 (19 exceedances), 81% lower than that in 2010 (75 exceedances), and also significantly lower compared to 2009 (37 exceedances), 2008 (82 exceedances), and 2007 (103 exceedances). In regard to 3-hour carbonyl sample results, one reported 3-hour acetaldehyde concentration (8.51 ppb<sub>v</sub>) monitored at the Clinton Dr. site slightly exceeded the odor-based AMCV (8.5 ppb<sub>v</sub>). Zero 3-hour concentrations of isovaleraldehyde exceeded its odor-based AMCV at Clinton Dr. in

2012, which represents a significant reduction (i.e., 100%) compared to three such exceedances in 2011, eighteen exceedances in 2010, and eight in 2009.

**Table 2. Odor-Based AMCV Exceedances by 1-Hour AutoGC VOC Concentrations**

Site	Chemical	Number of 1-Hour Concentrations above Odor-Based AMCV	Maximum Measured Concentration (ppb <sub>v</sub> )	Odor-Based AMCV (ppb <sub>v</sub> )
Milby Park	Styrene	6	52.5	25
	1-Butene	1	718.1	360
Lynchburg Ferry	Styrene	6	56.6	25
	Isoprene	1	155.4	48

The monitored odor-based AMCV exceedances would not be expected to cause direct acute adverse health effects (e.g., eye irritation). Additionally, the infrequency and low magnitude of the exceedances (e.g., all except three samples < 2 times the odor-based AMCV) and other considerations (e.g., odor characteristics for isoprene and 1-butene) are not indicative of persistent, strong odors with the potential to cause odor-related health effects (e.g., nausea, headache).

*Air Pollutant Watch List (APWL) Area for Odorous Hourly Styrene Concentrations – Lynchburg Ferry*

The number of 1-hour exceedances of the styrene odor-based AMCV at the Lynchburg Ferry site in 2012 (six) remains very low compared to historical exceedances (e.g., range of 27-92 exceedances for 2005-2010). The frequency, duration, and magnitude of these concentrations have fallen sharply since 2005 such that for the last two years (2011-2012), they are within that routinely permitted for air permit applications. This improvement is likely the result of efforts to reduce styrene emissions in this area and represents a maintained significant air quality improvement. In fact, using the six 2012 exceedances for each of the Lynchburg Ferry and Milby Park sites shows that the improvement in the frequency of odorous styrene concentrations calculated using the maximum for historical annual exceedances at the Lynchburg Ferry site (e.g., maximum reduction of 93% compared to 2005) is greater than that achieved at the Milby Park site (e.g., maximum reduction of 82% compared to 2008). The Milby Park site also had elevated frequencies of hourly odorous styrene concentrations for a period (2006-2008) but did not have styrene added to its APWL (Site # [APWL1207](#)). Goodyear mitigating the issue through operational changes, a reduction in permitted styrene emissions, and a Voluntary Emissions Reduction Agreement. Additionally, maximum hourly styrene concentrations at the Lynchburg Ferry site in recent years (2011-2012: 38.4-56.6 ppb<sub>v</sub>) are much lower than those in previous



years (2005-2010: 102.0-494.4 ppb<sub>v</sub>). Thus, both the frequency and magnitude of odorous styrene concentrations monitored at the Lynchburg Ferry site have shown significant improvement. Although styrene is currently listed on the APWL for this area (Site# [APWL1204](#)), the data discussed above from 2011-2012 indicate sufficient achievements in reducing ambient air concentrations such that the reported levels are no longer of concern for persistent, strong odors. This determination should be considered in context with the [APWL protocol](#).

## **24-Hour Concentrations**

The highest 24-hour isovaleraldehyde concentration in 2012 at the Deer Park site (0.275 ppb<sub>v</sub>) exceeded the odor-based AMCV for this chemical (0.1 ppb<sub>v</sub>), which is reported to be used in fragrances. The concentration monitored would not be expected to cause direct acute health effects. Additionally, although the perception of sufficiently strong and persistent unpleasant odors has the potential to cause odor-related health effects (e.g., nausea, headache), this concentration would not be expected to cause odor-related health effects due to the likely conservative nature of the odor-based AMCV for isovaleraldehyde and its odor characteristics. At the Mustang Bayou site in 2012, twelve acetaldehyde concentrations (8.52-16.4 ppb<sub>v</sub>) and eighteen butyraldehyde concentrations (1.59-4.13 ppb<sub>v</sub>) exceeded their respective odor-based AMCVs (8.5 and 1.4 ppb<sub>v</sub>, respectively). These monitored concentrations would not be expected to cause direct acute health effects. Additionally, although the perception of sufficiently strong and persistent unpleasant odors has the potential to cause odor-related health effects (e.g., nausea, headache), these concentrations are not indicative of strong odors with the potential to cause odor-related health effects due to the likely conservative nature of the odor-based AMCVs (e.g., upper end of the 50% odor threshold detection ranges are 48.65 and 3.1 ppb<sub>v</sub> for acetaldehyde and butyraldehyde, respectively), low magnitude of the exceedances (all acetaldehyde samples < 2 times the odor-based AMCV, with the same being true for all but four of the butyraldehyde samples which were < 3 times), and their odor characteristics (e.g., used in fragrances).

## **Annual Average Concentrations**

In 2012, all annual averages were below their respective long-term AMCVs for the third consecutive year in many years of sampling in Region 12:

- Based on the approximately 6,600 24-hour metals measurements, all monitored annual average concentrations of metals were below their respective long-term comparison values (e.g., long-term AMCVs);
- Based on the approximately 1,960 24-hour measurements, all annual average concentrations of carbonyls were also below their respective long-term AMCVs;
- Based on approximately 1,950 24-hour measurements, all annual average concentrations for PAHs/SVOCs were below long-term AMCVs; and
- Based on averages from approximately 86,400 24-hour canister measurements and approximately 3,877,000 hourly autoGC measurements (TCEQ, EISM, and three industry-sponsored autoGC sites), all annual VOC concentrations were also less than their respective long-term AMCVs.

In summary, 100% of all annual averages were below their respective long-term AMCVs and no long-term, adverse health or vegetation effects would be expected due to exposure to those concentrations.

*APWL Areas for Annual Benzene Concentrations – Galena Park and Texas City*

Annual average benzene concentrations for 2012 at the Galena Park site (1.0 ppb<sub>v</sub> based on every 6<sup>th</sup> day 24-hour canister data, 0.79 ppb<sub>v</sub> based on 11-month autoGC data) and the Marathon-sponsored Texas City site (0.75 ppb<sub>v</sub> based on autoGC data) remain well below the long-term AMCV, representing significant and maintained air quality improvements in these areas. Although benzene in the Galena Park area is currently on the APWL (Site# [APWL1206](#)), monitoring site data from 2008 to date indicate sufficient achievements in reducing ambient air concentrations such that the reported levels are no longer of concern for potential long-term, adverse health effects. The Lynchburg Ferry APWL area (Site# [APWL1204](#)) also had monitoring site annual benzene concentrations that were no longer of concern beginning in 2008, although benzene was removed from that APWL in 2010. Additionally, this year the [TCEQ proposed that benzene be removed from the Texas City APWL](#) area (Site# [APWL1202](#)) due to significant improvements in ambient air concentrations at the Marathon-sponsored site beginning in 2010 (since 2006, no other ambient air monitoring site in the Texas City APWL had annual benzene concentrations of potential long-term health concern). The improvements achieved at the Marathon-sponsored site in recent years are similar to those achieved at the Galena Park site since 2008. These considerations should be taken into account for the Galena Park area APWL (Site# [APWL1206](#)) in context with the [APWL protocol](#).

If you have any questions regarding this memorandum, please contact Joseph T. Haney, Jr., M.S. by phone at (512) 239-5691 or by email at [Joseph.Haney@tceq.texas.gov](mailto:Joseph.Haney@tceq.texas.gov), or Heather Reddick, M.P.H. by phone at (512) 239-0154 or by email at [Heather.Reddick@tceq.texas.gov](mailto:Heather.Reddick@tceq.texas.gov). For questions regarding the APWL, you may visit the TCEQ website at [http://www.tceq.state.tx.us/implementation/tox/AirPollutantMain/APWL\\_index.html](http://www.tceq.state.tx.us/implementation/tox/AirPollutantMain/APWL_index.html).



## Appendix 1. Monitored Air Toxics in Region 12 in 2012

### List 1. Target VOC Analytes in Canister Samples\*

1,1,2,2-Tetrachloroethane	Bromomethane	Methylcyclohexane
1,1,2-Trichloroethane	c-1,3-Dichloropropylene	Methylcyclopentane
1,1-Dichloroethane	c-2-Butene	m-Ethyltoluene
1,1-Dichloroethylene	c-2-Hexene	n-Butane
1,2,3-Trimethylbenzene	c-2-Pentene	n-Decane
1,2,4-Trimethylbenzene	Carbon Tetrachloride	n-Heptane
1,2-Dichloropropane	Chlorobenzene	n-Hexane
1,3,5-Trimethylbenzene	Chloroform	n-Nonane
1,3-Butadiene	Chloromethane (Methyl Chloride)	n-Octane
1-Butene**	Cyclohexane	n-Pentane
1-Hexene + 2-Methyl-1-Pentene**	Cyclopentane	n-Propylbenzene
1-Pentene	Cyclopentene	n-Undecane
2,2,4-Trimethylpentane	Dichlorodifluoromethane	o-Ethyltoluene
2,2-Dimethylbutane (Neohexane)	Dichloromethane (Methylene Chloride)	o-Xylene
2,3,4-Trimethylpentane	Ethane	p-Diethylbenzene
2,3-Dimethylbutane	Ethyl Benzene	p-Ethyltoluene
2,3-Dimethylpentane	Ethylene	Propane
2,4-Dimethylpentane	Ethylene Dibromide (1,2-Dibromoethane)	Propylene
2-Chloropentane**	Ethylene Dichloride (1,2-Dichloroethane)	Styrene
2-Methyl-2-Butene**	Isobutane	t-1,3-Dichloropropylene
2-Methylheptane	Isopentane (2-Methylbutane)	t-2-Butene
2-Methylhexane	Isoprene	t-2-Hexene
2-Methylpentane (Isohexane)	Isopropylbenzene (Cumene)	t-2-Pentene
3-Methyl-1-Butene	m & p-Xylene	Tetrachloroethylene
3-Methylheptane	m-Diethylbenzene	Toluene
3-Methylhexane	Methyl Chloroform (1,1,1-Trichloroethane)	Trichloroethylene
3-Methylpentane		Trichlorofluoromethane
4-Methyl-1-Pentene		Vinyl Chloride
Acetylene		
Benzene		

\* See List 6 for additional canister analytes monitored only at the Mustang Bayou site.

\*\* Not monitored at the Mustang Bayou Site.

### List 2. Target Carbonyl Analytes

2,5-Dimethylbenzaldehyde	Crotonaldehyde	Methacrolein
Acetaldehyde	Formaldehyde	m- & p-Tolualdehyde
Acetone	Heptaldehyde	o-Tolualdehyde
Acrolein - Unverified	Hexanaldehyde	Propanal - Propionaldehyde
Benzaldehyde	Isovaleraldehyde	Valeraldehyde
Butyraldehyde	Methyl Ethyl Ketone (MEK)	

### List 3. Target Metal Analytes

Aluminum (PM <sub>2.5</sub> , PM <sub>10</sub> )	Chromium VI (TSP*)	Nickel (PM <sub>2.5</sub> , PM <sub>10</sub> )
Antimony (PM <sub>2.5</sub> , PM <sub>10</sub> )	Cobalt (PM <sub>2.5</sub> , PM <sub>10</sub> )	Selenium (PM <sub>2.5</sub> , PM <sub>10</sub> )
Arsenic (PM <sub>2.5</sub> , PM <sub>10</sub> )	Copper (PM <sub>2.5</sub> , PM <sub>10</sub> )	Tin (PM <sub>2.5</sub> , PM <sub>10</sub> )
Barium (PM <sub>2.5</sub> , PM <sub>10</sub> )	Lead (PM <sub>2.5</sub> , PM <sub>10</sub> , TSP**)	Vanadium (PM <sub>2.5</sub> ***)
Cadmium (PM <sub>2.5</sub> , PM <sub>10</sub> )	Manganese (PM <sub>2.5</sub> , PM <sub>10</sub> )	Zinc (PM <sub>2.5</sub> , PM <sub>10</sub> )
Chromium (PM <sub>2.5</sub> , PM <sub>10</sub> )	Molybdenum (PM <sub>2.5</sub> , PM <sub>10</sub> )	

\*Only monitored at the Deer Park monitoring site; TSP = total suspended particulate.

\*\* Only monitored at the Deer Park and Houston East monitoring sites.

\*\*\* Only monitored at the Mustang Bayou monitoring site.

### List 4. Target PAH Analytes

Acenaphthene	Benzo(g,h,i)perylene	Indeno(1,2,3-cd)pyrene
Acenaphthylene	Benzo(k)fluoranthene	Naphthalene
Anthracene	Chrysene	Phenanthrene
Benzo(a)anthracene	Dibenzo(a,h)anthracene	Pyrene
Benzo(a)pyrene	Fluoranthene	
Benzo(b)fluoranthene	Fluorene	

**List 5. Target VOC Analytes in AutoG**

1-Butene	Benzene	n-Heptane
1-Pentene	c-2-Butene	n-Hexane
1,2,3-Trimethylbenzene	c-2-Pentene	n-Nonane
1,2,4-Trimethylbenzene	Cyclohexane	n-Octane
1,3-Butadiene	Cyclopentane	n-Pentane
1,3,5-Trimethylbenzene	Ethane	n-Propylbenzene
2-Methyl-2-Butene*	Ethyl Benzene	n-Undecane*
2-Methylheptane	Ethylene	o-Xylene
2-Methylhexane	Isobutane	p-Xylene + m-Xylene
2,2-Dimethylbutane	Isopentane	Propane
2,2,4-Trimethylpentane	Isoprene	Propylene
2,3-Dimethylpentane	Isopropyl Benzene -	Styrene
2,3,4-Trimethylpentane	Cumene	t-2-Butene
2,4-Dimethylpentane	Methylcyclohexane	t-2-Pentene
3-Methylheptane	Methylcyclopentane	Toluene
3-Methylhexane	n-Butane	
Acetylene	n-Decane	

\*Only monitored at the Danciger, Lake Jackson, Texas City 34th St., Wallisville Rd., Haden Rd., and Lynchburg Ferry monitoring sites.

**List 6. Additional Canister Analytes Monitored at Mustang Bayou**

1,2,4-Trichlorobenzene	2-Methyl-2-Pentene	cis-2-Octene
1,2-Dichlorobenzene	2-Propanol	cis-3-Hexene
1,3-Dichlorobenzene	4-Nonene	cis-3-Methyl-2-Pentene
1,4-Dichlorobenzene	Acetaldehyde	cis-4-Methyl-2-Pentene
1,4-Dioxane	Acetone	Cyclohexene
1-Decene	Acetonitrile	Dichlorofluoromethane
1-Heptene	Acrylonitrile	Diethyl Ether
1-Hexene	alpha-Pinene	Ethyl Alcohol
1-Methylcyclohexene	Benzaldehyde	Fluorobenzene
1-Nonene	Benzyl Chloride	Freon 113
1-Octene	beta-Pinene	Freon 114
1-Undecene	Bromochloromethane	Heptanal
2,2,5-Trimethylhexane	Bromodichloromethane	Hexachlorobutadiene
2,2-Dimethylpropane	Bromoform	Hexanal
2,4,4-Trimethyl-1-Pentene	Butyl Benzene	Indan
2,4,4-Trimethyl-2-Pentene	Butyraldehyde	Indene
2,5-Dimethylhexane	Chlorodifluoromethane	Isobutene & 1-Butene
2-2-3-Trimethylpentane	Chloroethane	Isobutylbenzene
2-Ethyl-1-Butene	Chloroprene	Methanol
2-Methyl-1-Pentene	cis-1,2-Dichloroethene	Methyl Ethyl Ketone

Methyl Isobutyl Ketone	n-Butyl Alcohol	trans-1,2-Dichloroethylene
Methyl Tert-Butyl Ether	n-Propyl Alcohol	Vinyl Acetate
Methylcyclopentene	p-Chlorotoluene	Vinyl Bromide
Naphthalene	p-Isopropyltoluene	
n-Butyl Acrylate	tert-Butylbenzene	